Medical Progress

Physical Activity and Health Maintenance—Exactly What Is Known?

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Broad claims have been made regarding the health benefits of physical activity. In analyzing the data on which these claims are based, including those on the risks of exercise, 5 of 13 proposed health benefits were found to have strong support in the literature. For the remainder the evidence is less conclusive or equivocal. Data regarding the risks of exercise are similarly varied. Proponents of physical activity should evaluate the documentation of its benefits and risks so as not to dilute the power of their remedy with unsubstantiated claims.

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Despite the current vogue that exercise now seems to enjoy, recent estimates of physical activity in the United States indicate that at least 40% of our population is completely sedentary, and only 20% exercises with an intensity and frequency generally recommended for cardiovascular benefit.[1] Yet exercise has been proclaimed to have lipid-lowering, antihypertensive, vasodilating, diuretic, anorexigenic, weight-reducing, cathartic, hypoglycemic, tranquilizing, hypnotic and antidepressive qualities, among others.[2] Is the majority of the American populace missing out on a miracle drug?

In previous overviews of the benefits and risks of exercise,[3,4] the quality of the data on which these claims are based has not been critically assessed. This report is a comprehensive evaluation of that data, which shows that many of the proposed benefits have little or no substantiation in the literature. To sharpen the focus on physical activity and health maintenance, only work involving healthy persons has been considered. Discussion of exercise as a therapeutic tool, such as in the treatment of diagnosed hypertension, obesity, diabetes mellitus or mental illness, can be found in most of the respective review articles cited herein.

Surety Rating

At the close of the discussion of each proposed benefit and risk of physical activity, an index of the surety that the literature allows is provided. This rating is a subjective judgment based on the data presented. It is designed to facilitate comparison of the support each claim enjoys. Readers are encouraged to review citations of interest and arrive at their own judgments. Ratings are based on the following scale:

- 0 = data are mixed; no point of view is favored;
- 1+ = most data are supportive but a significant fraction of reports (significant either in number or quality of results) does not support the claim;
- 2+ = established; little or no conflicting data.

The results of this rating process are presented in Table 1, which also serves as an index to the sections that follow.

Exercise Benefits

Blood Pressure

Exercise clearly has a role in the treatment of diagnosed hypertension.[5] But does physical activity help maintain normotension? This concept is suggested by observations that the age-associated increase in blood pressure characteristic of most modern societies[6] is not seen in more physically active societies such as the Kalahari bushmen.[7] Investigations of this relationship include cross-sectional studies of work-associated and leisure-time activities, longitudinal studies during exercise programs and epidemiologic cohort studies.

No consistent association between work-associated activity and blood pressure has been shown.[8,9] In contrast, leisure-time activity[9] and treadmill performance[10,11] (an indicator of physical fitness, presumably reflecting habitual physical activity) are inversely correlated with systolic and diastolic blood pressures. Moreover, longitudinal experiments with normotensive subjects have repeatedly shown decreases in blood pressure following exercise training programs.[5]

These studies have been supplemented by two recent cohort studies in which groups of subjects whose blood pressure was known in the past were reassessed for current blood pressure; changes in pressure over time were compared with the subjects' reported physical activity[12] or treadmill-tested fitness.[13] These investigations show that a sedentary life-style is associated with a 35% to 52% greater likelihood of hypertension developing compared with the physically active populations.

Overall these various reports suggest that leisure-time physical activity does indeed help maintain blood pressure within the normal range. Work-associated activity appears to lack the quality required to produce this effect. Surety rating 2+.

Serum Lipid Levels

Cholesterol carried by low-density lipoprotein (LDL-C) has been consistently associated with the risk of coronary

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ABBREVIATIONS USED IN TEXT

EEG = electroencephalographic
HDL-C = high-density-lipoprotein cholesterol
LDL-C = low-density-lipoprotein cholesterol

heart disease and that carried by high-density lipoprotein (HDL-C) with reductions in risk.[14] Considerable research has been devoted to defining the effects of regular physical activity on these serum lipoproteins.

Endurance athletes have lower LDL-C levels than sedentary controls in roughly two thirds of reports on this select group of subjects, but comparison between active and inactive members of the general population does not show this difference.[15] Reductions in LDL-C levels following exercise training programs have also not been consistently found.[16]

Associations of higher HDL-C levels with habitual exercise have been much more consistent, but numerous studies have shown conflicting results.[17] Prospective studies examining the effect of exercise training programs on HDL-C levels have also yielded conflicting results.[16] A recent well-designed longitudinal study, however, showed that changes in HDL-C values during exercise training were correlated ($P = .0008$) with the amount of exercise regularly performed.[18] Much of the inconsistency in the data regarding exercise and HDL-C levels may be explicable on the basis of difficulties in quantifying the amount of physical activity actually pursued by study participants.

At this time, however, the data on exercise and serum lipoproteins remain mixed. There is more support for exercise-induced changes in HDL-C levels than those of LDL-C. Surety rating 1+.

Smoking

Does physical activity help persons to avoid taking up smoking or help them quit once they have begun? Numerous studies of various designs have addressed this question.

Studies using questionnaires to assess physical activity and smoking behavior generally report an inverse relationship between these pursuits.[19] Several show a positive association between work-related physical activity and smoking, which again underlines the importance of distinguishing between work- and leisure-time physical activities. Treadmill-tested fitness is consistently inversely correlated with smoking behavior—that is, more physically fit persons, as defined by treadmill performance, smoke less.[10,20,21] Smoking itself, however, decreases treadmill performance through its effect on respiratory function,[22] so that those who smoke would be expected to appear less physically fit and, by implication, less physically active.

Longitudinal studies in exercise training programs have not shown a change in smoking behavior as untrained persons begin regular exercise.[23,24] These studies, however, were plagued with nonadherence to the exercise program; in one report the dropout rate for smokers was nearly twice that for nonsmokers.[24] Thus smoking behavior appears to be an effective predictor of exercise adherence, but conclusions regarding the converse cannot be drawn from these data.

Finally, results of a smoking history questionnaire administered to a group of 1,423 runners revealed that only a small percentage (15%—less than half the US average[25]) smoked before they began running,[26] which is consistent with the results of the longitudinal studies. Within this small group 81% of the men and 75% of the women stopped smoking when they began running.

It appears that the strong inverse correlation between exercise and smoking behavior may be largely due to a selection effect—smokers undertaking exercise programs less frequently than nonsmokers—rather than an effect of exercise itself. No conclusion on this issue is possible based on the available data. Surety rating 0.

Weight Control

The danger of obesity per se is not clear when a person exceeds ideal weight by less than 20% to 30%.[27] Because becoming obese clearly has an impact on psychological well-being,[27] however, and because cardiac risk factors such as hypertension, hyperlipidemia and diabetes are associated with weight gain,[14] it is reasonable to ascribe health benefits to physical activity if it can lower the risk of becoming obese.

The contribution of physical activity to total daily caloric expenditure is relatively small: if strictly adhered to, the minimum exercise program currently recommended[28] adds roughly 1,000 kcal per week to a sedentary person's weekly outlay of 14,000 kcal, only a 7% increase. The pattern of weight gain in the United States, however, is a slow but steady increase with age.[25] Such an increase can be produced

TABLE 1.—*Benefits and Risks of Physical Activity*

System	*Benefit*	*Surety Rating*	*Risk*	*Surety Rating*
Cardiovascular	Blood pressure control	2+	Cardiac arrest	2+
	Improved serum lipid profile	1+		
	Smoking cessation/prevention	0		
	Weight control	2+		
	Independent effect	2+		
Psychological	Improved affect	1+	Exercise addiction	1+
	Increased self-esteem	2+		
	Positive personality change	0		
	Improved cognition	0		
Musculoskeletal	Prevention of postmenopausal bone loss	2+	Amenorrhea/bone loss	2+
			Trauma	2+
CNS	Improved sleep	0		
Endocrine	Decreased risk of diabetes	0	Decreased libido	0
GI tract	Increased colonic motility	0	Diarrhea	1+

CNS = central nervous system, GI = gastrointestinal by a very small disparity between caloric intake and expenditure: consuming an excess of a mere 10 kcal per day leads to a 1-lb weight gain per year.[29] Clearly then, even a minimal program of physical activity added to the life-style of a sedentary person could protect against weight gain.

The foregoing analysis, of course, assumes that caloric intake remains constant. The question of whether increased caloric expenditure triggers increased caloric consumption has been studied since the 1950s and is still debated.[30] No day-to-day correlation between caloric output and intake has been shown, and most studies have shown a slight decrease in caloric consumption when physical activity increases, though these studies have been largely observational, not experimental.[31] Two recent truly experimental studies both show that caloric intake does not increase when obese subjects begin an exercise program,[30,32] and one reports a significant decrease in consumption equivalent to that during an imposed diet.[30] Unfortunately there are no similar studies available in nonobese subjects.

Finally, much has been made of the repeated observation that the basal metabolic rate remains elevated after an exercise period.[30,31] There is no clear consensus on how long this elevation persists, but estimates range from a few hours to two days.[31] A recent well-designed study, however, failed to find any significant elevation of the basal metabolic rate following even intense exercise.[33]

Physical activity clearly shifts the caloric intake-output balance toward the negative by increasing expenditure during activity. Whether expenditure remains elevated following exercise, and whether exercise may also decrease caloric intake, has yet to be determined. Surety rating 2+.

Independent Effect

Physical activity may reduce the risk of cardiovascular disease through a reduction in risk factors, as detailed above. Some evidence suggests that physical activity may have an independent effect as well.

An inverse relationship between physical activity and the risk of coronary heart disease has been shown in a wide variety of epidemiologic studies.[12,34-37] This relationship is best shown in studies of leisure-time activity and is generally not seen in studies of work-associated activity alone.[34]

Multivariate analysis is required to adjust for differences in risk factors that covary with physical activity and could account for the relationship observed. Applied to the Framingham data, this technique showed an independent effect of exercise only in men, not in women.[37] But the Puerto Rico Health Program[38] and a study of Los Angeles fire fighters and police officers[39] both report that physical activity was inversely correlated with coronary heart disease risk after adjusting for differences in blood pressure, serum lipid levels, relative weight and the presence or absence of cigarette smoking.

Moreover, the latter study joins three others[40-42] that present strikingly similar data, suggesting that the protective effect of physical activity is more pronounced in the presence of other risk factors. These investigators found that when risk factor levels were high, the risk reduction attributable to exercise was also dramatically high. This held true for blood pressure, relative weight, cigarette smoking and family history of cardiovascular disease; the serum cholesterol level was not examined. Collectively these works show that the reduction in coronary heart disease risk due to physical activity may not only be independent of reductions in other risk factors but actually more powerful when those risk factors are present. Surety rating 2+.

Mental Health

One of the most widely proclaimed benefits of physical activity is its effect on mental health. A vast literature comprising more than 1,100 articles has been produced in the study of this phenomenon.[43] Experimental design, however, has generally been so inadequate in these studies that their usefulness is limited.[44-47] (In a search for well-designed, randomized, experimental studies, I was forced to reject all but 12 reports.[43]) Of the plethora of proposed mental health benefits,[44] only four major areas have been consistently examined: affect, self-esteem, personality and cognition.

Affect: mood, depression, anxiety. Studies of longitudinal design have consistently shown a positive effect of exercise on mood, depression and anxiety.[47] More recent studies have distinguished between state (temporary or transient) and trait (personality-based) anxiety and have generally shown that exercise is effective in reducing only the former.[46] Only five studies in this area meet strict experimental criteria, however, and, of those, only one showed a positive effect of exercise training.[43]

Proposed mechanisms for this mood-improving effect include a change in central nervous system monoamine metabolism[48]—a hypothesis that has some support from animal experimentation but is wholly untested in humans—and the so-called endorphin hypothesis.[49] Enthusiasm for the latter has waned since it has been shown in a double-blind crossover experiment that naloxone (an opiate antagonist) does not block the mood shift associated with running,[50] although it has been argued that the naloxone dose was inadequate.[49] Surety rating 1+.

Self-esteem. Of 13 studies, 11, including 4 that meet strict experimental criteria,[43] have shown improved self-esteem following exercise training.[47,51] Interestingly, the only two reports that failed to show such an effect did not use aerobic training programs.[47] It should be noted that of all the proposed health benefits of exercise, none has more unequivocal support than these findings on self-esteem.

For both affect and self-esteem, however, it remains entirely possible that the observed positive effects of exercise training programs are due to factors other than physical activity itself. None of the studies to date have effectively controlled for other proposed mediators such as an expectancy effect[46]; the experience of mastery[43]; an effect of mere cognitive diversion, allowing distraction[49] or simply "time out"[48] from belittling, depressing or anxiogenic circumstances, or learning to reinterpret somatic symptoms of anxiety.[43] Surety rating 2+.

Personality. There are few studies relating personality change and physical activity, and none shows unequivocal improvement. There is considerable evidence, however, that physical activity has both a psychological and somatic relaxation effect.[46] For example, 15 minutes of walking was shown to be a more effective muscle relaxant than 400 mg of meprobamate in elderly anxious subjects.[52] This has led to an examination of exercise as an adjunct means of altering the type A behavior pattern. Four recent studies (two published only in abstract) found a reduction in the physiologic or the psychometric (or both) correlates of type A behavior following exercise training.[46] Two others, however, found no such effect in men who have had a myocardial infarction or in college women participating in aerobics programs.[44] Surety rating 0.

Cognition. Research on physical activity and cognitive function has been scattered among children, adults and geriatric populations. The physical activity regimens have varied widely. Moreover, there is far more variation than consistency in the psychological measurement tools used, such as Wechsler Intelligence Scales, arithmetic tasks, IQ tests and so forth. The data are therefore very difficult to interpret. In studies of both children and adults, the results are largely equivocal.[44] There is slightly more support for an association between physical activity and improved cognition in the elderly,[46,47] but there are contradictory reports of similar design. More research using standardized activity regimens and testing devices will be required to clarify this area. Surety rating 0.

Bone Density

Loss of bone density begins for most women in their fourth decade but becomes dramatic after menopause.[53] Those who have not adequately invested in their "bone bank" before this period of steady loss can eventually fall below a critical level of bone strength (fracture threshold) and become susceptible to vertebral, radial or femoral neck fractures.[54] Treatment of these fractures currently costs an estimated 3.8 billion dollars annually.[55]

Physical stress on bone is associated with changes in its form, a relationship long recognized and codified as Wolff's law.[56] This relationship and the natural history of postmenopausal osteoporosis lead naturally to the hypothesis that a woman might, by engaging in physical activity, be able to promote sufficient bone deposition to keep herself above the fracture threshold during postmenopausal bone loss.[57]

The hypothesis has not been directly tested, but considerable data exist to support it. In cross-sectional studies, Olympic athletes,[58] cross-country runners,[59] marathoners (male[60] and female[61]), ballerinas and weight-lifters[62] have been shown to have greater bone density than sedentary controls. Tennis players have greater bone density in their dominant arm, unless ambidextrous.[63] No studies failed to show such a relationship when comparing those who are regularly physically active with inactive subjects.

It has also been shown that in young adults protection from gravity by bed rest or space travel leads to bone loss,[64] and that this bone is regained when normal daily activity is resumed.[65] Prospective experimental studies have been done only in postmenopausal women[66-69]; all showed a small increase in bone density in the exercising group, whereas control groups experienced a steady decline. Unfortunately, there are no longitudinal studies in the population in question—that is, premenopausal women.

Thus, while the hypothesis that regular physical activity can lower the risk of postmenopausal osteoporosis has not been tested directly, evidence from various sources supports this concept. Surety rating 2+.

Sleep

Does increased physical activity improve the quantity or quality of sleep? The prevalence of sleep disorders and the complications that follow the pharmacologic therapy thereof make this an important question.

Despite the common belief that intense physical activity "makes you tired"—that is, more ready to sleep or inclined to sleep longer—electroencephalographic (EEG) data on sleep following various exercise conditions do not show such an effect. Of 17 EEG-monitored sleep experiments, none showed a difference between regular exercisers and sedentary persons in sleep latency, wakefulness during the night or total sleep time.[70-72] Similarly, there was no demonstrable effect of a short, intense bout of exercise on any of these variables.[73]

Interestingly, although fitness does not appear to affect objective assessments of sleep, a person's perception of the quantity and quality of sleep may be affected by regular physical activity. Fit subjects' sleep logs indicated a shorter perceived sleep latency and higher ratings of sleep quality compared with the reports of unfit subjects, according to the single available study of the subjective aspects of sleep.[71]

Proponents of physical activity should recognize that there is no objective evidence of improved sleep with regular exercise. Surety rating 0.

Diabetes Risk

Exercise has long been recognized as having beneficial effects in patients with diabetes mellitus,[74] possibly since as early as 600 BC.[75] Does physical activity play a role in preventing non-insulin-dependent (type II) diabetes mellitus as well? No experimental data address this question directly, but some laboratory studies and epidemiologic reports bear on the issue.

It has been shown repeatedly that exercise affects glucoregulation directly by increasing insulin receptor density[76,77] and thus increasing insulin sensitivity.[78] The relationship between improved insulin sensitivity and the risk of type II diabetes mellitus is unclear, however.[79] Similarly, glucose clearance has been shown to correlate dramatically with exercise performance,[80] but again there are no data regarding glucose clearance and the risk of type II diabetes developing.

Abnormal glucose tolerance, however, is recognized as an early stage in the progression toward clinically unmistakable diabetes.[81] A demonstration that exercise helps maintain normal glucose tolerance would provide evidence for a preventive effect of physical activity in regard to the development of type II diabetes mellitus. Unfortunately, both cross-sectional and longitudinal studies have produced equivocal results: of 12 such reports, half showed superior glucose tolerance in exercisers; the remaining 6 found no correlation.[82]

Two recent epidemiologic studies of natives of the South Pacific suggest that physical activity may be one of the variables accounting for the fact that the rates of type II diabetes in rural populations are a third those of natives who have become urbanized. Dietary differences do not account for the observed disparity in incidence.[83] The rural rate was still half the urban rate when adjusted for differences in body weight, but only for men; the rates for women were similar for both populations after this adjustment.[84] The authors suggest that the men's greater physical activity during work may afford them this relative protection.

Thus there is no direct evidence of a role for physical activity in preventing type II diabetes mellitus. Glucose tolerance, the most directly related metabolic variable, has not been shown to be affected by exercise. Insulin sensitivity and glucose clearance are altered by regular physical activity, but their relationship to the development of type II diabetes has not been delineated. Epidemiologic data indicate that the concept of a protective effect should not be abandoned, however. Surety rating 0.

Colonic Motility

Because continued bed rest is commonly associated with constipation,[85(pp92-93)] and because diarrhea has been reported as a side effect of long distance running,[86,87] it is tempting to assume that physical activity has a laxative function. If true, this would constitute yet another important benefit of exercise, because constipation is a very common problem in ambulatory[88] and inpatient care. Indeed, in a gastroenterology text of recent vintage (1983), exercise is promoted as part of the treatment regimen for complaints of constipation: "the patient should be urged to get some exercise every day, particularly if he is a desk-bound worker or a housewife [*sic*]."[89(p724)]

Yet virtually no data exist to support or refute this common belief. An article from 1970 that is repeatedly cited (such as by Vena and Garabrant and co-workers[90,91]) indicates a laxative effect of physical activity, but in this study nearly all subjects were inpatients with gastrointestinal tract disease, physical activity was not a controlled independent variable, and there are no quantitative data reported.[92] The only other pertinent study is available in abstract only and shows no consistent change in whole-gut transit time following an increase in physical activity.[93]

More than constipation may be at issue here. Striking epidemiologic studies have recently been published indicating that the incidence of colon cancer is higher in men whose occupations are classified as sedentary ($P < .001$[90] and $P < .0001$[91]). No such relationship was found for any other cancer site, including the rectum. Because no definite effect of physical activity on colonic motility has been documented, however, these results are difficult to interpret. There is a clear need for simple, well-designed tests of gut transit time and physical activity. Surety rating 0.

Exercise Risks

Sudden Death

Until recently it was argued by some that vigorous physical activity, or at least marathon running, might award its participants an immunity to coronary artery disease.[94] In addition, however, to autopsy-proved coronary artery disease in marathoners,[95] there are now at least 75 reported cases of sudden death while jogging or running. Most of these endurance exercisers died of coronary insufficiency.[36]

Sufficient data have now been gathered to permit a quantitative estimate of the increase in cardiac risk during exercise. The death rate for regular joggers in Rhode Island over a five-year period was seven times higher while exercising than while sedentary.[96] A more recent study allows comparison of the increased risk incurred during exercise with the decrease in risk associated with regular physical activity.[97] As shown in Figure 1, the average incidence of cardiac arrest for a habitually vigorous man, which includes his risk while exercising (the transient square wave increase), is still a third the incidence rate for a sedentary man. Moreover, the risk assigned to the sedentary man assumes that he never engages in strenuous physical activity.

It will be most interesting to see if subsequent investigations confirm these dramatic data. Their implications regarding the net cardiac risk and benefit of physical activity are quite clear. Surety rating 2+.

Exercise Addiction

There are anecdotal and case reports that in some persons who take up endurance exercise, a psychophysiologic addiction to it develops. These "addicts" believe they require daily exertion to cope with life; they have withdrawal symptoms, including irritability, depression and anxiety, when external circumstances force abstention, and they have a tendency to continue exercise when it is medically or socially contraindicated.[98]

Only one experimental study has been done to try to elicit these symptoms in regular runners. This experiment involved abstaining from exercise for only 24 hours; results were weakly positive in a small subset of subjects (seven runners).[99]

None of the case reports of addiction involve persons pursuing physical activity in moderation: all are regular endurance exercisers whose workouts total as much as 100 miles per week. Yet precise descriptions of the addictive phenomenon in these cases clearly imply that certain personalities are at risk before they even begin an exercise program.[100,101] Unfortunately, these reports do not agree on particular traits that might be sought to identify such persons. Surety rating 1+.

Musculoskeletal System—Amenorrhea and Bone Loss

The pathogenesis of exercise-associated amenorrhea is not well understood. It appears that high levels of exercise training may interact with a reduction in body fat percentage (resulting at least in part from the exercise training itself) and with other factors such as stress and poor diet, leading to an alteration of the endocrine milieu, a cessation of menstrual cycling and resultant tonically low estrogen concentrations.[102] Alarmingly, exercise-associated amenorrhea has recently been associated with decreased bone mineralization: nonmenstruating exercisers were shown in several studies to have a lower bone density than eumenorrheic controls.[103-107]

Thus, while physical activity may slow or prevent bone demineralization (see the section on Bone Density), too much exercise ironically may lead to increased bone loss. No specific level of exercise training has been associated with the development of amenorrhea. It is sobering, however, that the incidence in competitive athletes may be as high as 50%.[102]

Nevertheless, the general intensity, frequency and duration used in the studies of physical activity for preventing bone loss are well below those of an amenorrheic athlete. It therefore seems reasonable to conclude that, if practiced in moderation, physical activity sufficient to protect against postmenopausal osteoporosis carries little risk of inducing the opposite phenomenon. Surety rating 2+.

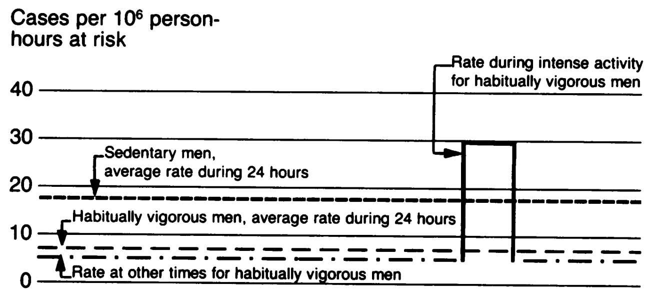

Figure 1.—Risk of primary cardiac arrest during vigorous physical activity and at other times, by level of habitual activity (from Siscovick et al[35]; reprinted by courtesy of *Public Health Reports*).

Musculoskeletal System—Trauma

The risk of bodily injury varies not only with the particular sport involved but also with factors such as climate, equipment and training. Estimating a person's risk is difficult.[108] But some perspective can be gained from the experience with running: for example, among 922 participants in a 10-km road race, a third had a musculoskeletal injury related to running in the following year.[26] The available data, however, clearly indicate that the incidence of injury is directly proportional to exercise intensity, frequency and duration. No data are available to suggest a threshold level of activity beyond which risk climbs steeply; such data would be valuable in selecting a level of activity that optimizes exercise benefits while minimizing risk. Surety rating 2+.

Decreased Libido

There are anecdotal reports of a decrease in libido in some distance runners during intense training. Interestingly, serum testosterone levels were shown in one report to be lower in (male) runners than in controls, but libido was not investigated in parallel.[109] No data on this subject are available for women, though intense exercise clearly affects the female hypothalamo-pituitary-gonadal axis (see Bone Density). Surety rating 0.

Diarrhea

As noted in the discussion of colonic motility, diarrhea has been reported as a common problem in distance runners.[87] There are case reports but no data sufficient to estimate the incidence of this complaint nor the exercise intensity required to produce it. Again, exercise intensity and frequency appear to play a role: in the case reports, episodes of diarrhea were associated with increased or particularly strenuous exertion.[86] Surety rating 1+.

Conclusion

The major findings of this report can be summarized as follows:

- Physical activity has been consistently associated with an increase in self-esteem and a decrease in the risk of hypertension, obesity and postmenopausal osteoporosis. It also appears to have an independent effect in reducing cardiovascular risk.
- Physical activity has not been shown to promote smoking cessation, affect personality or cognition, decrease the risk of diabetes, improve sleep or increase colonic motility.
- For other proposed benefits—improved serum lipid profile and improved affect—there are more supportive than negative data.
- Leisure-time and work-associated activities are not equivalent in their health maintenance effects: the latter has not been shown to promote normotension or to have an independent effect on cardiovascular risk; further, it is positively rather than inversely related to smoking behavior.
- Exercise-associated risks of cardiac arrest, amenorrheic bone loss and musculoskeletal trauma are well documented; the risk of exercise addiction, diarrhea and a decrease in libido have much less support in the literature. With the exception of the risk of cardiac arrest, all these negative consequences of exercise have been shown to be minimized or eliminated by exercising in moderation.

In the current world of competing health care schemes and claims, one of the primary strengths of traditional medicine is its adherence to rigorous scientific standards in evaluating new therapeutic agents. Many of the proposed benefits of exercise do not meet such rigorous standards.

Fortunately there is no need to wait for further research to elevate these claims to legitimacy, as may occur for some of them. Physical activity has already been shown to be an effective agent in health maintenance. Practitioners are urged to make assessment of exercise habits a regular part of the medical history and exercise prescription[110,111] a regular part of their preventive care. Physical activity, however, is not a miracle drug. We would do well not to dilute the elixir with unsubstantiated claims.

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